SOURCE DATA COMPRESSION AND DECOMPRESSION IN CODE SYMBOL PRINTING AND DECODING

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a coded symbol encoding and decoding system for creating and reading one-dimensional and two-dimensional coded symbol patterns. More particularly, the present invention relates to a method and apparatus for compressing and/or encrypting data, encoding the data to represent a coded symbol pattern, and subsequently, reading, decoding, and decompressing and/or decrypting the data.

2. Description of Related Art

It is common within the automatic data collection industry to encode data conveying information about an object into a coded symbol pattern. The coded symbol pattern is printed on a label, and the label is attached to the object. Alternatively, the coded symbol pattern can be printed directly onto the object. An electro-optical imaging system can then be used to read the coded symbol pattern and translate it back into the original data. Systems of this nature are commonly used in various applications, such as inventory control, point of sale identification, or logistical tracking systems.

The data is encoded into the coded symbol pattern in accordance with a given symbology. Symbology refers to the rules that define the way data is encoded into a printed pattern. Traditionally, the automatic data collection industry has used only one-dimensional symbologies. A one-dimensional symbology defines a one-dimensional pattern of symbols. A bar code is an example of a one-dimensional symbology, and comprises a parallel arrangement of varying width bars and spaces. Numerous well known one-dimensional bar code symbologies exist, including Codabar, Code 39, and Code 93. FIGS. **6*a–c*** show exemplary bar codes created using those respective symbologies.

Recently, the automatic data collection industry has begun to use two-dimensional symbologies. A two-dimensional symbology defines a two-dimensional pattern of symbols, and is generally capable of representing more data than a one-dimensional symbology. Numerous well known two-dimensional symbologies exist including Codablock, PDF417, Code One, Maxicode, Vericode, and Data Matrix. FIGS. **6*d–i*** show exemplary two-dimensional symbol patterns created using those respective symbologies. The term coded symbol, as used herein, includes both one-dimensional and two-dimensional symbologies.

The physical size of the printed code symbol is directly related to the amount of data in the data source that is encoded into the printed code symbol. The size of the printed code symbol can therefore be reduced by reducing the size of the data source prior to encoding the data. With the advent of two-dimensional symbologies, the trend in the industry has been to encode increasingly larger amounts of data into a coded symbol pattern. It has therefore become increasingly important to reduce the size of the data before encoding it in order to control the size of the printed code symbol.

Data compaction is a technique for reducing the size of a data set by using shorter code words to represent the data than were used in the original data set. Data compaction works, however, only if the code words are larger than is necessary to represent all the data in the data set. If that is the case, data compaction reduces the size of the code words to a size that is minimally necessary to represent all the data in the data set. For example, if it is known that a data file contains eight-bit bytes representing ASCII code words, data compaction could be used to reduce the size of the data file by replacing each ASCII code word with a smaller code word. As is known, ASCII code contains 128 elements. Because seven bits are sufficient to represent 128 elements, data compaction could be used to reduce the size of the data file by replacing the eight-bit ASCII code words with seven-bit code words.

Data compaction has been used in the automatic data collection industry to reduce the size of a data set before encoding the data. For example, U.S. Pat. No. 5,380,993 to Komai discloses a system that uses a data compaction algorithm to reduce the number of digits used to represent data prior to encoding the data into a micro-bar code, and thereby reduce the physical size of the resulting micro-bar code.

A significant drawback to automatic data collection systems that use data compaction to reduce the size of data, such as Komai, is that data compaction can be used only if the type of data in the data set to be compressed is known ahead of time. This is because the size of the code words used to represent the data cannot be reduced unless it is known that the code words are larger than necessary to represent all the data in the data set.

Another significant drawback to automatic data collection systems that use data compaction is that data compaction does not take advantage of the inherent redundancy in most data sets. Such systems therefore do not achieve the size reduction that could be achieved by taking advantage of the redundancy.

Data compression is another data reduction technique, and it does not suffer from the above mentioned disadvantages of data compaction. More specifically, data compression reduces the size of a data set by taking advantage of the redundancy inherent in most data sets. Data compression can therefore be used even when the type of data to be compressed is not known ahead of time, and data compression often achieves results that are far superior to results achieved using data compaction. Several well known data compression techniques exist including statistical compression, run length compression, and substitutional compression.

Traditionally, data compression has been used in the data storage field to reduce the size of data prior to storing the data in a memory so that the data occupies a smaller area of the memory. Data compression has also been commonly used in the communications field to reduce the size of data prior to transmitting the data over a communications system. Despite its popularity of usage within the data storage and communications fields, however, data compression has not been used in the automatic data collection industry. This may be partly due to the fact that, in the automatic data collection industry, the total amount of data encoded into a single coded symbol pattern has traditionally been small. With the advent of two-dimensional symbologies, the trend in the industry has been to encode increasingly larger amounts of data into a coded symbol pattern. Because the potential advantages of using data compression increase as the size of the data to be compressed increases, compressing data prior to encoding it into a coded symbol has become increasingly advantageous.

A drawback with data compression is that it does not always result in a smaller data size. In fact, data compression, can in some cases, actually increase the size of